Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

EDITOR'S NOTE.—Leake and Force, of the United States Public Health Service, in their studies on the immunological relationship of alastrim (1921), inoculated monkeys and rabbits, using crusts and pustule contents from alastrim patients in Jamaica and Haiti. They summarized the results of their experiments as follows:

A vesico-papular eruption was produced in monkeys by inoculation both with crusts and with vesicle contents from alastrim patients. The animals were protected against reinoculation with alastrim and vaccine virus. Rabbits inoculated with alastrim showed no eruption, but were almost completely immune to vaccine virus. Rabbits previously inoculated with vaccine virus gave positive intracutaneous reactions to smallpox crusts, alastrim material, and vaccine virus, but remained negative to chicken pox crusts.

The fact that definite immunity to vaccinia is produced by previous inoculations with alastrim is additional evidence of the essential identity of alastrim with smallpox. (Reprint No. 669 from the Public Health Reports, June 24, 1921, pp. 1437–1443.)

ARSENIC AS A LARVICIDE FOR ANOPHELINE LARVÆ.

By M. A. BARBER, Special Expert, and T. B. HAYNE, Technical Assistant, United States Public Health Service.[1]

Roubaud [2] has successfully used trioxymethylene, or paraformaldehyde, in poisoning anopheline larvæ. This powder, undiluted or mixed with some inert dust, is simply strewn on the surface of the water, where it is eaten by the larvæ. The poison acts on the nervous system of the insect, causing paralysis, and when eaten in sufficient quantity causes death within a few minutes. It is said to be harmless to any animal, aquatic or otherwise, except the surface-feeding anopheline larvæ. A sublethal dose is said by the author to confer on anopheline larvæ a degree of resistance to a subsequent dose.

We have confirmed the work of Roubaud to the extent that we have found trioxymethylene very toxic to anopheline larvæ, both in laboratory and in field tests. It seemed worth while, however, to extend this line of investigation and to search for some substance cheaper and more poisonous to the larvæ than trioxymethylene; since the use of a fine powder which acts through ingestion would seem to be a very promising measure against anopheline larvæ. These larvæ lie at the surface of the water, and in feeding turn the head halfway around into such a position that the feeding brushes carry to the mouth any particles lying on the surface-tension layer of the water. The larvæ swallow all floating substances that are small enough to enter the mouth easily, and are quite indifferent as to whether these are food or poison. No bait of any kind is required to make these larvæ eat anything that is offered them.

---

[1] Some of the later experiments in this work were done by Assistant Sanitary Engineer W. H. W. Komp.

[2] Roubaud, E.: Compt. Rend. des Séances de l'Acad. des Sci. Vol. 171, 1920, p. 51. Ibid., Vol. 170, 1920, p. 1521.

Moreover, poisons in the form of a fine powder are very conveniently distributed. The surface-tension layer of the water affords a convenient support for the powder, whether it be heavier than water or not, and the floating particles are further distributed by currents of air after they reach the water. Again, the insect, in feeding, draws to it particles lying at some distance from the head.

After a trial of a considerable number of substances, we found compounds containing arsenic most promising, and of these, Paris green has proved most efficient.

LABORATORY EXPERIMENTS.

A laboratory test was devised by which the toxicity of a substance for anopheline larvæ could be quantitatively measured. The powder to be tested was strewn lightly upon the surface of water in a Petri or other convenient dish, a larva was pipetted into this dish, and the time when the particles of powder began to be swept into the mouth was observed carefully under a hand lens. At the close of any desired feeding period, the feeding time being reckoned by the number of seconds during which particles were entering the mouth, the larva was pipetted out, washed in two waters in order to free it from any adhering poison, and then deposited in a second dish for subsequent observation. A number of larvæ were thus fed on the substance to be tested, and the length of time of survival and the proportion surviving after a given dose gave a rough estimate of the toxicity of the substance. Highly soluble substances were mixed with pollen or some other inert powder before testing. In case we desired to ascertain the time of survival after the maximum dose merely, a number of larvæ were placed in a dish, the poison was strewn over them, and the time of survival of each larva was noted. In most of our experiments the size of the larvæ and the temperature of the water were also noted.

A large series of laboratory experiments was carried out in which a number of substances were compared, including several of the commoner arsenic-containing compounds. One or two protocols, given in brief, will illustrate the method and results of these experiments.

Ten anopheline larvæ, the size of which varied from one-quarter grown to full-grown, were fed on trioxymethylene, and nine similar larvæ on Paris green, the dosage varying from "minimum"—that is, the ingestion, or apparent ingestion, of one or two particles—to a dose represented by three seconds' feeding. Of the larvæ fed on trioxymethylene none was dead 16 hours after feeding, while 4 of the 9 fed on Paris green were dead within 3 hours, and a fifth in less than 5 hours. Since one could not always be sure that a larva taking the "minimum" dose had really swallowed the poison, the experiment was repeated, allowing doses of 3 to 5 seconds. Of 12 fed on Paris green 11 died within periods varying from 85 to 103 minutes, while of 12 fed on a similar dose of trioxymethylene 6 survived at least 4½ hours. The 6 of this lot which died, however, showed a shorter average time of survival than that of the 11 which succumbed to Paris green; 62.5 minutes was the average survival time of the trioxymethylene and 90.7 of the Paris green.

In another series trioxymethylene, lead arsenate, and Paris green were compared, the dosage of the first two poisons varying from 4 to 15 seconds and that of the Paris green from 2 to 10 seconds. All of the larvæ fed on the trioxymethylene, 4 in number, died in less than 1 hour; of the Paris green series 9 out of 10 died within less than 2 hours and the tenth after about 7 hours; of the lead-arsenate series practically all survived until the next day or later.

As is illustrated by the two protocols given above, the Paris green did not always cause a more rapid death than trioxymethylene, but the proportion surviving after a very small dose was always less in the case of Paris green than with any other poison tested, a point of considerable weight in favor of Paris green as a practical larvicide, since it is not always possible to give the larger doses when treating a pond or stream.

The extreme sensitiveness of anopheline larvæ to Paris green was impressed on us by several laboratory accidents in which the very slight amount of powder accidentally thrown into the air during the process of mixing or measuring the poison caused a high mortality among larvæ kept in the stock pans on the same table.

Paris green freed from the water-soluble portion by long treatment with water was still poisonous for larvæ, so it is probable that certain of the digestive fluids of the larvæ act as solvents for the poison.

Lead arsenate and arsenic trioxide ("white arsenic") were both much inferior to Paris green as larvicides for anopheline larvæ, and powdered arsenopyrite seemed to be wholly inert. We have tested the calcium arsenate in common use for dusting cotton plants, both in the laboratory and in the field, and find it decidedly less effective than Paris green. We would not recommend its use in place of Paris green except in case of emergency. In one experiment we successfully treated about 1,200 square feet of Myriophyllum-covered water with about half a pound of calcium arsenate mixed with sand. In other field experiments where considerably less quantities were used the results were very unsatisfactory.

FIELD EXPERIMENTS.

In field experiments a sketch was usually made of the breeding place to be treated, and before treatment a number of dips were made with a definite sized dipper over different parts of this area, the location of the dips being approximately indicated on the sketch. In recording the anophelines present before and after treatment, the number of the pupæ and the number and size of the larvæ were recorded, the sizes being usually designated as full, three-fourths, one-half, one-fourth, and small. The reexamination of the breeding place was usually done at least three and one-half hours after treatment, and often on the next day.

A protocol of a field experiment will illustrate the method and results: The breeding place was a pond covered with grass, the blades of which projected an inch or two above the surface of the water. The temperature of the water at the surface was 35.2° C. and at a depth of 25 centimeters (10 inches), 26° C. Approximately 370 square meters (4,000 square feet) were treated with 10 cubic centimeters of Paris green mixed with about a liter (quart) of fine sand. The dust was thrown into the air by hand, the main distribution being effected by the wind. The sum of 31 dips over the whole area before treatment was as follows: Pupæ, 1; full-grown larvæ, 12; three-fourths-grown larvæ, 3; half-grown larvæ, 7; one-fourth-grown larvæ, 16; small larvæ, 124; total, 163. About 24 hours after treatment the sum of 31 dips over the same area was as follows: Pupæ, 2; full-grown larvæ, 0; three-fourths grown, 1; half grown, 0; one-fourth grown, 3; small, 6; total, 12. In this experiment the amount of poison used was very small, and the grass formed a barrier to its spread, but there was an almost complete destruction of the larger larvæ and over 95 per cent of the smaller ones. Other experiments have been done where the numbers of larvæ were much larger and the percentage destroyed was much higher, and in some experiments no survivors could be found.

The following kinds of breeding places have been successfully treated: Impounded water with larvæ protected by floating wood; cold water in a ditch immediately below a spring, the larvæ being protected by thick water cress; grass-covered ponds and those covered by Myriophyllum; ground below a spring and covered with a thin layer of water; wet pasture with breeding in cow tracks; an old ditch, the water of which was covered with duckweed and partly protected by overhanging weeds; various small pools without any particular covering. In small pools a few pinches of the diluted Paris green sufficed to destroy the larvæ. The species of anopheline apparently makes no difference as regards their resistance to this poison.

QUANTITY AND METHOD OF USE OF PARIS GREEN.

Paris green in antianopheline work should be diluted with a large proportion of inert dust. Only very small doses are necessary to poison larvæ, and the dilution enables one to spread a relatively small quantity of the poison over a large surface. Further, any risk of poisoning the operator or the water treated is minimized by the use of the diluted dust. As a diluent we have successfully used fine sand, rotten wood dust, and road dust. Road dust, preferably mixed with some fine clay, seems to be as effective as any. The addition of weight in the form of some coarser sand is helpful in enabling one to direct the dispersal of the lighter dust. Some of the diluting dust sinks on contact with the water, but most of the arsenic is left on the surface. Flowers of sulphur has not proved a suitable diluting dust, possibly because so large a proportion of it remains floating that it is ingested with the Paris green, which latter is then too much diluted. A dilution of about 1 part of the poison to 100 parts of the inert dust seems to be a favorable mixture.

The quantity of Paris green to be used must depend somewhat on the character of the breeding place. Where there is much high grass, reeds, and the like, one would use somewhat greater quantities of the poison than where the surface of the water is clear or covered by low surface vegetation only. Since the poison is relatively inexpensive, and the danger of poisoning the water of the breeding place is small, quantities somewhat larger than those given in the protocol would seem to be advisable, possibly about 10 c. c. (approximately 12 grams, 0.43 ounces avoirdupois, 0.6 cubic inches, or two level teaspoonfuls) to 90 square meters (1,000 square feet).

A slowly settling cloud of dust carried along by a light wind is apparently the best agent for the distribution of the dust, and the main thing is to start this cloud in the right place and direction. A single cloud may destroy larvæ over a wide area and at a considerable distance from the operator. We have tried certain mechanical means for distributing the dust, such as the dust-guns used in dusting arsenic on cotton plants, but thus far we have succeeded best by simply throwing the dust into the air by hand. The cloud can thus be formed high or low, to the right or to the left, depending on the force and direction of the wind. The pole and bag method, sometimes used for dusting plants, has been found useful in treating a breeding place at the bottom of a deep ditch.

TIME OF DAY FOR THE USE OF THE POWDER.

The best results are to be expected on a sunny day when the powder is spread after the sun is well up and the dew has disappeared from any vegetation covering the breeding place.

FREQUENCY OF TREATMENT.

The frequency of treatment of a breeding place must depend largely on the temperature of the water. In a recent experiment anopheline larvæ were thoroughly destroyed over a given area. The place was kept under observation from day to day, and frequent collections of larvæ were made. Eleven days after treatment fully grown larvæ and a few pupæ were found. In this breeding place, then, it would have been necessary to repeat the treatment within ten days. The weather was warm and the temperature of the water very high, and it is probable that in this pond the growth of the larvæ (larvæ of *A. quadrimaculatus*) was nearly at its maximum rate.

COST.

Paris green was recently quoted at 22 cents per pound, f. o. b. New York City, packed in 300-pound barrels. Small quantities may be purchased in drug stores for $1 per pound. At 25 cents per pound the amount sufficient for at least 1,000 square feet, 10 c. c., would cost about seven-tenths of a cent. The calcium arsenate in common use for dusting cotton plants may be purchased for about 15 to 20 cents per pound. The use of a powder instead of a liquid should greatly lower the cost of transportation. Usually a dust suitable for dilution can be found in the neighborhood of the breeding place, so that one has to transport only a pound or so of Paris green for the treatment of a large area.

DANGER OF POISONING THE OPERATOR OR THE WATER TREATED.

The danger to persons engaged in distributing arsenic-containing dusts as larvicides would seem to be mainly through the possibility of inhalation of the poison or its absorption through the skin rather than through ingestion. In our search for information regarding the possible harm to men or domestic animals engaged in distributing arsenical dusts as insecticides, we sent letters of inquiry to 17 United States or State agricultural experiment stations in the cotton or tobacco growing States, in the hope that information might be obtained from those who have had much practical experience with these dusts and their possible harmful effects. In some States these arsenical dusts, calcium arsenate in particular, have been used by the ton in combating the boll weevil. Of the 16 stations replying to our inquiry, 14 of the correspondents had had experience in the use of arsenical dusts. Of these 14, about half had knowledge of some injury to man or domestic animals through the use of these arsenical dusts. The lesions reported were chiefly of the acute type and of a minor degree, such as sores on exposed parts of the body, irritation of the bronchial tubes, and sometimes intestinal disorders—lesions which usually healed promptly. Some more serious cases of chronic poisoning were reported to us by Mr. B. R. Coad, in charge of the Delta Laboratory, U. S. Bureau of Entomology, at Tallulah, La., who kindly wrote us a full description of these cases. The cases were of the cumulative type of poisoning, and occurred exclusively among persons who had worked with the dusts in close quarters for several years. They occurred as the result of exposure to calcium arsenate as well as to other kinds of arsenical dusts. "The chronic types of poisoning are practically always accompanied by some dermatic disorder, the injury of which varies widely with the individual, and is somewhat recurrent. Furthermore, in extreme cases we find neuritis and occasionally some fairly pronounced heart symptoms. It has proved a very obnoxious ailment, and, furthermore, a very stubborn one. Apparently it is brought about by a saturation of the system with arsenic, and the victim is nearly always hypersensitive to arsenic exposure. In the case of constant exposure the mucous membranes of the nose and throat reach such a condition that they are exceedingly sensitive to mechanical irritation by any form of dust, and a slight exposure to dust brings on an attack which very closely resembles hay fever."

It is to be remembered that these chronic cases followed a long and intimate exposure to arsenic dusts. Mr. Coad was of the opinion that the amount of exposure incident to the antianopheline work we have described would probably not lead to any particular danger. It is significant that so little trouble is reported by experiment station workers and by other persons who have used arsenic dusts extensively for some years. Possibly their immunity has been due in part to the fact that they use principally the slightly water-soluble calcium arsenate, and that cotton-plant dusting extends over a comparatively short period each year. However, in antianopheline work where such small quantities of highly diluted Paris green are used, and where the work is wholly out of doors, simple precautions should suffice to protect the user, nor would a health officer anticipate any strenuous objections from the people of a community to the use of a substance so commonly employed as an insecticide.

In our experiments we have used no precautions other than to stand to the windward of the dust cloud—the place where one would naturally stand in distributing the dust—and we have experienced no harmful results whatever. However, even with the small quantities used in larvicide work, it is well to remember that one is working with a poison and that some precautions should be taken, at least until the matter is further investigated. It is probably sufficient to keep to the windward of the dust clouds and to avoid inhaling the dust as far as possible. In case a great deal of exposure is necessary, one should use some precaution to keep any large amount of Paris green from entering the clothing or accumulating anywhere on the skin.

As regards the danger of poisoning the water treated, it should be emphasized that only a minute quantity of Paris green is dusted over a very large surface, and of that compound only a very small fraction is water-soluble. We have never observed any effect of the poison on culicine larvæ or on any aquatic insect or animal, however delicate, other than the surface-feeding anopheline larvæ. In particular, we have never observed any indication of harm to top-feeding minnows or to any other natural enemy of larvæ. The danger to domestic animals through drinking treated water seems very remote. In order to meet any objections on the part of the owner of a breeding place, one might arrange to have the stock removed from the breeding place for a day or so, but the owner will hardly insist on this precaution when it is explained to him that the powder is the same as that commonly used against insects and that only a very small quantity of it is to be used on a large body of water.

In sum, the possible advantages of arsenic dust used against anopheline larvæ are its cheapness, portability, ease of distribution by means of the wind, and the possibility of using it over areas difficult of treatment by methods now in use. The chief disadvantage is that its use is limited to anopheline larvæ—ova and pupæ of all kinds, and culicine larvæ are apparently unaffected. It is believed, however, that this method will have a place in antimalarial work, especially in places not easily drained and so covered by vegetation or other obstacles as to render them inaccessible to natural enemies of larvæ, or to other methods of treatment.

DEATHS DURING WEEK ENDED NOV. 26, 1921.

Summary of information received by telegraph from industrial insurance companies for week ended Nov. 26, 1921, and corresponding week, 1920. (From the Weekly Health Index, Nov. 29, 1921, issued by the Bureau of the Census, Department of Commerce.)

	Week ended Nov. 26, 1921.	Corresponding week, 1920.
Policies in force	47,761,374	45,212,203
Number of death claims	7,188	7,399
Death claims per 1,000 policies in force, annual rate	7.8	8.5